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CAVIAR and OTHER FISH ROE PRODUCTS

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UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF COMMERCIAL FISHERIES

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CAVIAR AND OTHER FISH ROE PRODUCTS

The roes or eggs of fish are among the most valuable of the miscellaneous food products from fishery sources. With few exceptions, almost any species may be utilized if the roe is large enough. The roes of sturgeon, salmon, mullet, alewife, whitefish, sea herring, cod, haddock, and tuna are the most important ones used in fish curing. A variety of curing methods may be used. Sea herring roe is air dried by Alaskan Indians. Sturgeon and salmon eggs are salted in brine and sold under the name caviar. Mullet roes are dry-salted, salted and air-dried, and brine-cured in the southern Atlantic States. Cod roe is salted and smoked in the northern European countries. Tuna roe is salted and air-dried in the Mediterranean area.

CAVIAR

Caviar may be made from the roe of various species of fish but in the popular mind, caviar and sturgeon are synonymous. The reason for this belief is that sturgeon caviar was the first variety to be sold commercially.

To make good caviar, the roe of the sturgeon should be taken just before it is fully developed or "ripe," and while it is still hard. If the roe is immature or "green" it does not make a good grade of caviar. Soft, fully developed roe in spawning condition also makes an inferior product.

The amount of roe obtained from an individual fish usually runs from 10 to 70 pounds, varying with size, species, and locality. Occasional large specimens may yield more than 100 pounds of roe.

The "cow" sturgeon should be landed as soon as caught, the belly slit, and the roe removed. The roe must not be washed with fresh water as this tends to soften and break the shells of the individual eggs. It is also reported that roe washed in fresh water will not cure so well and is inferior in both texture and flavor. Exposure to direct sunlight is also a cause of deterioration. Rigid cleanliness and speed in handling are essential to production of a good quality caviar.

The roe is placed on a work table with part of its surface made of a ¼-inch wire-mesh screen. A second finer mesh screen below this slants at a 45° angle into a large tub. Some curers place a sieve with a ¼-inch mesh directly over a large wooden mixing tub. The egg sac is slit carefully so that the individual eggs are not damaged and the roe is separated into portions. The curer rubs portions of the roe on the sieve gently, using the full palm of the hand. The individual eggs are separated from the membrane and fall through the mesh onto the screen below, sliding gradually into the tub. Slime, blood, and bits of

membrane drain through the second screen. Vigorous rubbing is apt to crush many individual eggs, and to force pieces of tissue and other foreign material through the mesh of the sieve. This foreign material must then be separated from the eggs in the mixing tub, thus delaying the curing process.

The eggs, which look like small shot, are now ready for salting and mixing. Caviar makers claim that quality depends largely on skill in salting and type of salt used. Some caviar makers with European experience claim that the best quality caviar can only be made if Luneberg or Russian caviar salt is used. Others report excellent results with the mild-cure salt used for salmon. All agree that the salt must be distributed evenly over the eggs. This is accomplished by sifting the salt through a fine sieve, over the egg mass.

It is agreed that the cure should be mild as heavily cured roe will sell only to the cheapest trade, and that the amount of salt needed will vary according to the condition of the roe, the season (less salt is needed in cold weather), shipping conditions, and the species of sturgeon used. The amount of American dairy or mild-cure salt should be consistently somewhat less than the European salt since the former contains less chemical impurities and, therefore, penetrates more rapidly. European references commonly give 8 pounds of salt per 100 pounds of roe as an all around average (Hoffman (undated) and Jacobsen 1926).

As soon as the required amount of salt has been added, eggs and salt should be thoroughly mixed by hand. Paddles or other stirring utensils are not recommended. The process of stirring is the most delicate operation in curing caviar. Only trained men of much experience can do it really well, avoiding unnecessary breakage of eggs and securing an even blend of eggs and salt. At first the egg mass will be sticky but a brine is soon formed by the strong attraction of the salt for the liquid content of the eggs. Cobb (1919) stated that both hands should be used to mix the eggs and salt thoroughly for 5 to 8 minutes until foam or slime appeared on top of the egg mass. The mass is allowed to stand for about 10 minutes and is then mixed again. By this time a copious brine should have formed, so that the eggs will pour readily. If the operation has been properly performed a slight noise is perceptible when the mass is stirred, like small pieces of glass rubbing against one another.

The salted eggs are transferred to trays with a fine wire-mesh bottom ($\frac{1}{32}$-inch mesh) holding about 10 pounds each. These trays are placed between cleats on slanting boards set against a wall. They remain here until the brine is completely drained away. Sufficiency of drainage is determined by pressing against the underside of a tray at a single point. If the mass cracks open, the cure is completed and the mass may be removed. The time required for drainage is reported to

vary from 2 to 4 hours. Good draining is very important, for if the caviar is "soupy" when received by the dealer it must be drained again, and the resulting loss in weight is charged against the shipper.

Radcliffe (1925) reports that:

> The impression of some fishermen that the more salt added the heavier will be the caviar is wrong. The addition of salt extracts the water from the eggs and reduces their weight. For the caviar to retain its delicious flavor the roe must be mildly cured. If an excess of salt has been used, the caviar on being treated by the canners will taste so strongly of salt as to be practically unsalable. The only changes in the amount of salt depend upon temperature conditions. In cold weather as little as one pound of the Luneberg salt or one-half pound of the dairy salt to 18 pounds of roe may be sufficient, but in very warm weather as high as one pound of the Luneberg salt or one-half pound of the dairy salt to 9 pounds of roe may be required. If the roe is too ripe, and the entire egg mass is soft and tender to the touch, it may be put into a strong brine until it is thoroughly "struck" with salt. This, however, makes an inferior grade of caviar.

The sturgeon caviar is packed in small kegs to a net weight of 100 pounds. If the total amount to be shipped is less than this weight, wooden tubs or "kits," or large tin cans with tightly fitting covers may be used. Some curers line the containers with vegetable parchment paper before filling. The caviar should not be dipped out of the sieves in filling. Turn the sieve upside down over the shipping container and allow the contents of the sieve to fall out in a mass. The containers are not headed immediately but set in a cool place to stand for a few days until the caviar has settled. The head space thus formed is filled with caviar so that no air space is left, the top is fixed on tightly, and the container is ready for shipment. If possible, light and dark colored roe should be cured and packaged separately. Mixing the two colors gives the product a speckled appearance, making it less valuable than caviar of uniform color. Under no circumstances should any chemical preservative be used.

Caviar should be shipped and held in chill storage at 34° to 36° F. If the curer does not have refrigerated shipping facilities the container should be placed in large barrels or boxes and surrounded with ice.

When packaged for the United States retail trade, caviar is filled into cans holding 1½ to 2, 4, and 8 ounces or into nappy glass containers holding about the same amount. Occasionally 1- and 2-pound containers are used, mostly for the hotel trade.

Grain Caviar in Barrels

Grain caviar in barrels is prepared when weather conditions do not permit packing of very lightly salted caviar in jars; when a more durable product is desired, as for export, or where refrigeration is lacking for shipment and storage. Grain caviar in barrels is also cured when the quality of raw material does not meet the requirements for caviar in jars. The quality requirements for grain caviar in barrels are less strict than for caviar in jars. There are three grades of

the finished product, "highest," "first," and "second." Only three quality factors are recognized in grading. First, the degree of ripeness. This is the same for all three grades and simply requires that the eggs must not be over-ripe. The second factor is the size and color of the eggs. For the highest grade there should be little difference in size and color. For the "first" grade, eggs of the nearest colors or sizes can be mixed; that is, light gray with gray, large grain with medium. There are no size and color standards for "second" grade. The third factor is flavor. Muddy and grassy, or so-called natural flavors, are not permitted in any of the three grades.

The method of preparation of grain caviar in barrels is the same as for that in jars, except that the caviar in barrels is more heavily salted. The amount of salt used for this product varies from 7.5 to 10 percent of the weight of raw material depending on the location, season of the year, and quality of the product. Length of salting is from 5 to 8 minutes, the variation factors being the same as for the amount of salt. The caviar is allowed to drain on wire-mesh screens for a longer time than that to be packed in jars. Surplus moisture must be more completely removed. Draining requires a period of from 2 to 4 hours. When sufficiently drained, it is packed in barrels lined with a linen cloth or parchment paper. The barrels are set in chill storage for 24 to 48 hours to allow the caviar to settle, so that there are no air spaces. The barrels are then filled, headed, and shipped. While more durable than caviar in jars, it requires refrigeration at all times.

Pasteurized Grain Caviar

Caviar is pasteurized to obtain the maximum length of preservation. It is not considered as high in quality as fresh grain caviar and is intended for export, or use where refrigeration is not available.

Cod Roe Salted and Smoked

The whole lobes of roe, fresh and in good condition, neither too ripe nor green, are cleaned of all slime, blood, bits of gall bag, and other offal. After being washed in sea water and drained for a few minutes, the roe are salted down in barrels. The roe must be salted whole without injuring or breaking the enclosing membrane, and must not be salted too much, just sufficiently to keep them from decomposing and to give them an orange-red color. The amount of salt used is believed to average about 10 pounds per 100 pounds of roe. When the roes are cured, that is, when they have acquired the desired color, they are removed and washed thoroughly in sea water several times. The roes are then hung out in the air on wires or drying racks, protected from the direct rays of the sun if it is bright. After drying about 24 hours, when no surface moisture is apparent and they feel dry to the touch, the roes are ready for smoking.

The roes are hung in the smokehouse on sticks, like fillets, or are

laid on trays with wire-mesh bottoms, and cold smoked for 2 or 3 days until they acquire a dark-brown color. After smoking, the enveloping membrane or skin of each roe sac is split and removed from the lobe. The mass of separate eggs is then packed in barrels which are then tightly closed and placed in a normally cool place (about 55° to 60° F.), for a month or 6 weeks. The barrels should be watched closely during thi riod or fermentation may set in and progress too far before it is detected. As soon as it is determined that fermentation has begun, enough salt to arrest fermentation should be mixed through the roe. This is estimated at about 15 pounds per 100 pounds of roe.

Through the fermentation the roe is given a slight acid flavor and a taste resembling that of fermenting beer or wine, which must be stopped by adding salt at a certain point in the process, to be determined only through experience. The salt used to arrest fermentation must be fine and of the best quality. If the roe seems too dry, enough olive oil is added to moisten the product. After the roe has been thoroughly mixed with salt it is packed in tin containers, hermetically sealed but not processed. The usual size is a ¼ round tin with a net weight of about 3¾ ounces. Glass jars are also used in the ¼ size, with the same net weight.

Mullet Roe

The quality requirements of the raw material are the same for the two methods of dry-salting followed here. That is, the roe must be fresh, of good color, and the skin of the roe sac must not be broken. The roe must not be over-ripe nor should it be too green or underdeveloped.

In both methods the first step is to prepare the roe by freeing the lobes from blood, gall bags, bits of intestine, and black skin. After being washed thoroughly and allowed to drain, they are ready for salting.

Dry-Salting Mullet Roe

In the first method, after this preliminary treatment, the lobes of roe are rolled in fine salt.

The lobes are picked up with as much salt as will cling and packed in tubs or boxes, with a scattering of salt over each layer. They remain in salt for at least 48 hours and may then be placed in chill storage and held in salt for some time if not marketed immediately. Sometimes salted-mullet roe is held in dry salt at room temperature. In packing for sale, it is taken out of salt and placed in fillet boxes with a light scattering of fresh salt. The consumer freshens the roe to suit the individual taste.

Air-Dried and Pressed Mullet Roe

In the second method the washed and drained lobes of roe are rolled in fine salt, using about 1 pound of salt to 10 pounds of roe. The lobes are removed from the salt in from 6 to 12 hours and are brushed well to remove any traces of excess salt. They are laid out to dry in direct sunlight, usually on a shed roof.

During the first day of drying, the lobes of mullet roe are turned at least every hour and in the evening are brought indoors. Any night moisture such as dew, fog or rain falling on the roe after drying has started will spoil or at least damage the product. Boards and weights are placed on the roes during the first night or two in order to compress them slightly. Curing requires about one week under good drying conditions. Drying is completed when the roe is reddish-brown in color and feels hard. The thumb should make no impression. The dried roe is usually dipped in melted beeswax which acts as a protective covering and is recommended as an additional aid in preservation.

After being allowed to cool for about 15 minutes the roe is wrapped in waxed paper, packed in wooden or tin boxes and stored in a cool, dry place. The product is sliced thin and eaten as an appetizer without further preparation.

Salmon Caviar

To be suitable for caviar, the salmon eggs must be absolutely fresh, free from blood, and of clear color and good consistency. Large eggs do not make good caviar. Most salmon caviar is prepared from the roe of silver and chum salmon, which have been found best suited for the purpose (Jarvis 1935).

The egg sac is split and rubbed gently over a half-inch mesh screen. The eggs fall onto an inclined screen of fine-wire mesh leading into a large shallow box. The eggs drain on the screen and finally slide into the box. The eggs are cured in brine testing 90° salinometer, usually made from fine mild-cure salt. The salmon eggs are stirred occasionally with a wooden paddle to insure thorough mixing and equal absorption of brine. The brining time varies with season, temperature, and humidity, besides size, consistency, and freshness of the eggs. The time required varies from 15 to 30 minutes. The packers determine the sufficiency of cure by noting the change in consistency of the eggs. The interior must coagulate to a certain jelly-like consistency but the eggs must not be shrunken. After brining, the eggs are dipped from the vat, placed on wire-meshed screens and drained overnight, or for a period of about 12 hours.

After draining, the eggs are filled into small kegs holding about 100 pounds and lined with vegetable parchment paper. The kegs are covered and allowed to stand until the eggs settle. The headspace caused by settling is then filled with more caviar, the kegs are headed, and put in chill storage at 34° to 36° F. until shipped. They are shipped under refrigeration.

Salted and Air-Dried Tuna Roe

Spent roe is not used for salting and drying. Only the roe should not be too small and unripe, nor be in the spawning stage. The roe is taken out of the tuna as soon as the fish are landed and should be prepared immediately. Great care

must be taken in gutting so as not to damage the roe or taint it by breaking the gall bladder.

There is apparently some variation in the method of cure, according to locality. According to one source the tuna roe is washed when removed from the fish and allowed to drain for a few minutes. It is then put in a tank partly filled with saturated salt brine (100° salinometer or 25° B.). Additional salt is thrown in so that the brine will not be weakened too much by extraction of moisture. The roe is left there about 12 hours. It is then removed from the brine, rinsed, and wiped off with the hands. Then the lower part of each lobe is pierced with a knitting needle to allow the moisture to escape. The roes are then placed in rows on a marble slab sprinkled with three-quarter ground salt. Additional salt is scattered over the roes and a second marble slab set on top. After several hours, or, at the latest, the next morning, the roes are weighted down more heavily. Two days later the weights are removed, the roes are turned over, and the lower parts of the lobes are pierced again to allow the moisture in the tips to escape. After sprinkling with fine salt for the second time the roe is weighted down once more and allowed to stand 4 or 5 days.

The weights are then removed from the roes, which are rinsed quickly in a strong salt brine (almost saturated) and prepared for air drying. Two parallel slivers of cane are placed at the narrowest part of the lobes, where they grow together, and are tied. A loop of string is fastened to this frame, with a hook at the end of the loop so that the roes can be hung from a line for air drying. After drying in the shade for several days, the time varying according to temperature, humidity, air circulation, and size of roe, the roes are hard and reddish-brown in color. When brushed with olive oil, or coated with beeswax, they are ready for market (Dieuzeide and Novella 1942).

In Spain the salting and drying of tuna roe is more of a large-scale industry than in France. As soon as the roes are separated from the viscera of the tuna, they are sorted and graded. Only the large and medium roes are taken for curing. Small roes are canned.

After washing thoroughly in sea water the roes are allowed to drain a few minutes, then salted down in kenches on the concrete floor of the fish house. Each roe must be completely covered with salt. The kenches are from 2 to 3 feet high. The tuna roe is left in salt from 24 to 36 hours. It is then taken out of the salt, rinsed in sea water and allowed to drain, then placed in rows on a large board that has been sprinkled with fine salt. The roe is sprinkled with salt, a board sprinkled with salt is placed on top, repeating until there is a stack of six or seven layers. The completed stack is set in a simple screw press with large cross beams and placed under light pressure.

Classen (1946) reports the fol-

lowing process:

Every day the roes are taken out, rinsed with sea water, and the salt renewed (each day a lesser quantity of salt being used), and put again in the press with the pressure increased. After a week or so no salt is added and the pressure is again increased. After a few more days (in all, the roe remains in the presses 9–10 days) the roe is finally taken out from the press, washed, and rubbed very thoroughly in fresh water with a hard fibre brush to remove any impurities, salt, and slime, and hung on the beams of the drying ground in the same way as mojama, in the shade of rush mats. The color of the roe changes during the drying process from pinkish-yellow to a deep red-brown on the outside and a rich orange color inside.

An average of 15 days is required to dry the roe. It is then taken down and packed in paper-lined wooden boxes, ready for shipment. Sufficiency of drying is tested by pressing the lobe between thumb and forefinger. When the thumb makes no impression, the cure is finished. Classen estimates the average weight of the roes before salting as 4 kilograms (8.8 lb.) a pair, and that in curing and drying they lose about 60 percent of their weight, so that a pair will have a dried-weight of approximately 1.6 kilograms (3.5 lb.).

Salted and dried tuna roe is regarded as an hors d'oeuvre of high quality. To serve, it is cut in thin slices and mixed with sliced onion and vinegar, or marinated in oil and vinegar.

Tuna Caviar

A paste made from small, deformed, or damaged tuna roes is reported to be sold commercially in Spain under the name of tuna caviar. The method of preparation is as follows:

The roes are washed, split open, then boiled in a brine made in these proportions:

80 liters (84.5 qt.) water	1 kilogram (2.2 lb.) sliced onions
2 kg. (4.4 lb.) salt	8 bunches celery
8 sliced peeled lemons	10–12 large green Spanish peppers

Black peppers, garlic, bay leaves, to taste

The liquid is brought to a boil. The roes, in a wire basket, are immersed in the liquid. The pieces stick together very easily, causing uneven cooking, and therefore, must be stirred gently from time to time. If stirring is not done carefully many grains separate from the mass and are lost. When thoroughly cooked, about 20 minutes of simmering, the baskets are taken out and set aside to drain and cool. When the pieces are cool enough to handle, the eggs can be separated from the fibrous tissue in lumps without the use of a knife. The next step is to pass the eggs through a meat grinder, using the plate with smallest holes. The eggs now have a pinkish-yellow color. They must be handled immediately as they turn gray if left exposed to the air. The ground roe and other ingredients are placed in a mixing machine together with following:

30 kilograms (66 lb.) ground roe.	3600 grams (8 lb.) canned sweet peppers, ground
2500 grams. (5.6 lb.) lard	

2500 grams (5.6 lb.) ground onions (fried golden brown in lard or oil)

0.9 liter (1 qt.) vinegar 2½ percent)

300 grams (11 oz.) salt

300 grams (11 oz.) sweet red pepper, ground (sweet paprika)

15 grams (0.5 oz.) ground cloves

45 grams (1.5 oz.) ground white pepper

3 liters (3.2 qt.) stock used in cooking roe, filtered

The ingredients are thoroughly mixed until a paste of satisfactory texture is obtained. The paste is filled immediately into size ⅛ cans with capacity of 100 grams (3½ oz.) net. The cans must be well filled, so that no air remains in the can, but care must be taken to avoid overfilling. The cans are sealed and heat processed. The process is 108° C. (266.4° F.) for 50 minutes.

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